MAX494 Single Event Effects Test Results
Tested at Texas A&M Univ. Cyclotron Facility, MAR 03

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Introduction:

This test was performed on the Maxim MAX494 for validation for flight on the Gamma-ray Large-Area Space Telescope (GLAST) project. Testing was performed at the TAMU Cyclotron Radiation Effects Facility. The devices were tested for single event transients (SET) and single event latch up (SEL).

Device Tested:

The MAX494 is a quad, micropower, single-supply, rail-to-rail operational amplifier used in the anti-coincidence detector (ACD) and data acquisition (DAQ) subsystems of the large-area telescope (LAT instrument). Two devices under test (DUTs) were irradiated with 5 different heavy ions each. The devices were delidded for exposure. The DUTs were marked MAX494ESD, and the lot date code was 0229.

Test Facility:

The devices were irradiated at the Texas A&M University Cyclotron Institute. The cyclotron was tuned to 15MeV/amu for the neon, argon, krypton, xenon, and gold used in testing. The following configurations were used to achieve the full spectrum of linear energy transfers (LETs) necessary to obtain proper data.

Ion	Angle of Incidence	LET or LET_{eff} (MeV•cm^2/mg)	Range in Silicon (μm)
Neon	0, 35, 45	2.8, 3.4, 3.9	318, 260, 225
Argon	0, 35, 45	8.6, 10.5, 12.1	230, 188, 163
Krypton	0, 35, 45	28.8, 35.2, 40.7	172, 141, 122
Xenon	0, 35, 45	53.1, 64.8, 75.1	157, 129, 111
Gold	0, 35	87.1, 106.3	154, 126

Test Setup:

The devices were mounted in air at the end of the Radiation Effects Facility line off of the K500 cyclotron. The SET/SEL signal from the DUT was taken from the output pin (pin 1). Power was supplied by an HP6654A quad channel DC power supply. Channel 2 biased the DUT at +3.3V/0V V_{CC} with channel 3 providing a +2.5V input with the op-amp configured as a unity gain follower. Channels 1 and 4 were used to power the peripheral circuitry. The output was monitored by a custom test setup, operated from a laptop using National Instruments' LabView™ software, connected to the test board by GPIB interface. Two FET probes were used to capture the transients, one for positive going and one for negative going transients. The electrical setup is given in Fig. 1.

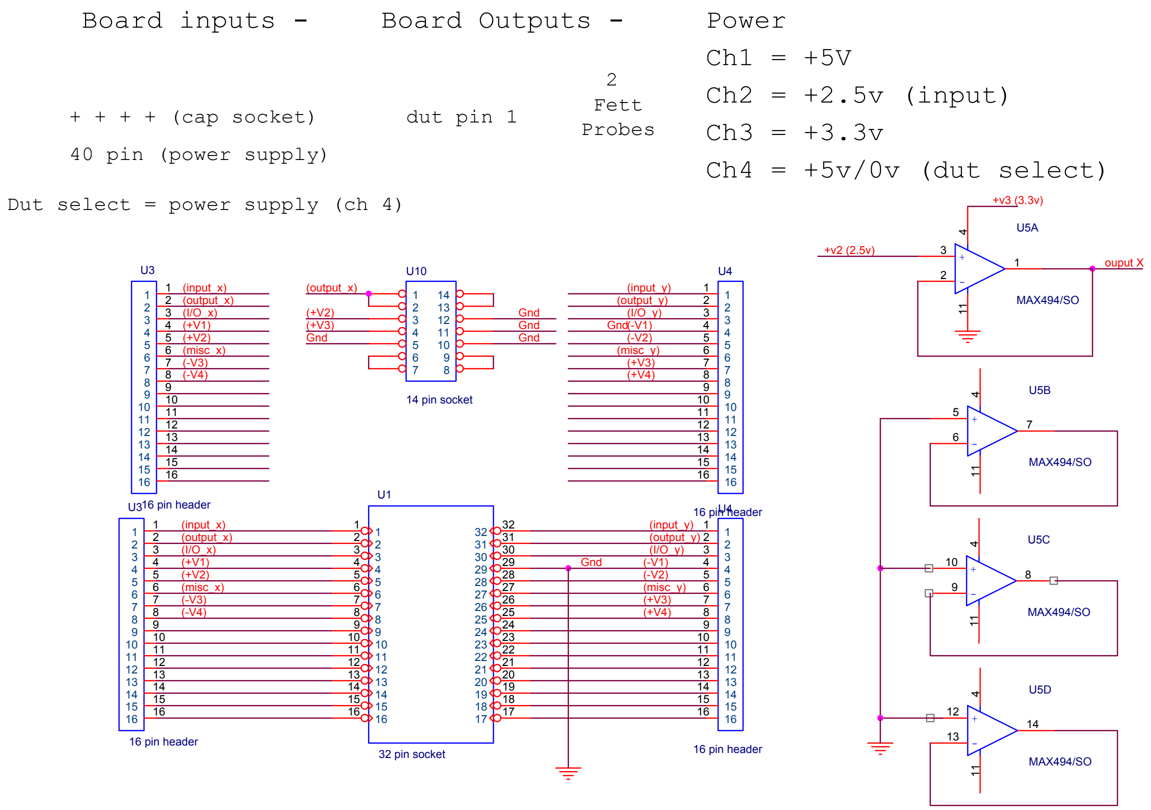

Figure 1: Test configuration circuit and details for the MAX494.

Test Results:

No single event latchups (SELs) were observed to an LET_{eff} = 106.3 MeV•cm^2/mg during testing.

Many single event transients (SETs) were observed. Their behavior is relatively uniform. The vast majority of the transients are negative going, full drop to ground from an input level of +2.5V. The saturation cross section is 8x10^{-4}cm^2. The full with, half maximum (FWHM) of the largest transients are ~2µs and the total duration from initiation of the transient to complete recovery is ~4µs. Typically 10% to 20% of the total number of transients at any given LET will be shorter in duration and/or shallower in voltage drop. The LET_{th} for negative going transients is less than 2.75MeV•cm^2/mg (the lowest LET tested). The Weibull fit of the data suggests that the devices are very likely to be proton sensitive to SETs. Positive going SETs only occur at higher LETs. The LET_{th} is less than 35MeV•cm^2/mg (Kr at a 35° angle of incidence). The positive going transients never exceed 10% of the total number of transients. The transients are uniform in appearance: full jump to the positive rail (+3.3V), FWHM is ~2.2µs and the total duration from initiation of the transient to complete recovery is ~5µs. A plot of the separate positive and negative going transients for each DUT is given in Figure 2. The full combined cross sections for each DUT is given in Figure 3. An example of a typical negative going transient is given in Figure 4 and an example of a typical positive going transient is given in Figure 5.

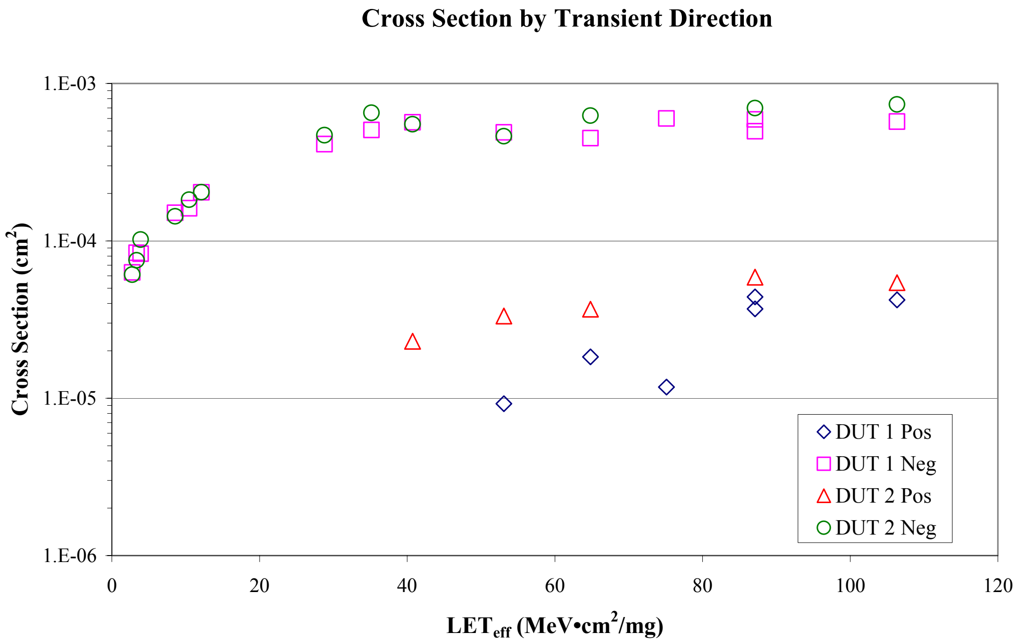

Figure 2: Cross sections for both DUTs, broken down by positive-going (Pos) and negative-going (Neg) transients. Note that the positive going transients begin at a much higher LET.

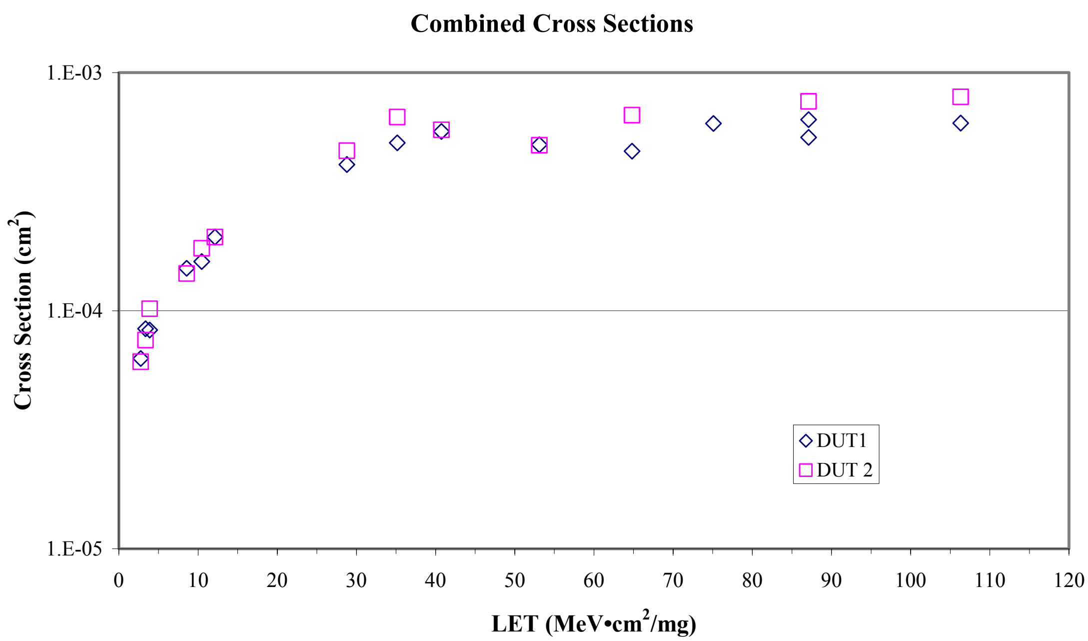

Figure 3: Cross sections for both DUTs.

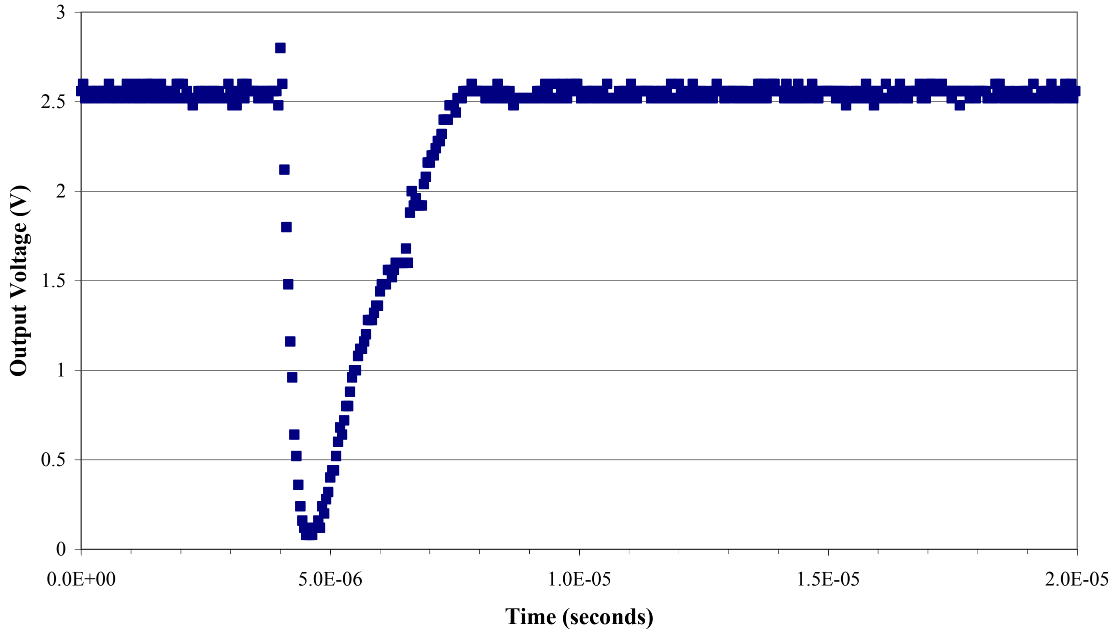

Figure 4: Typical negative going transient.

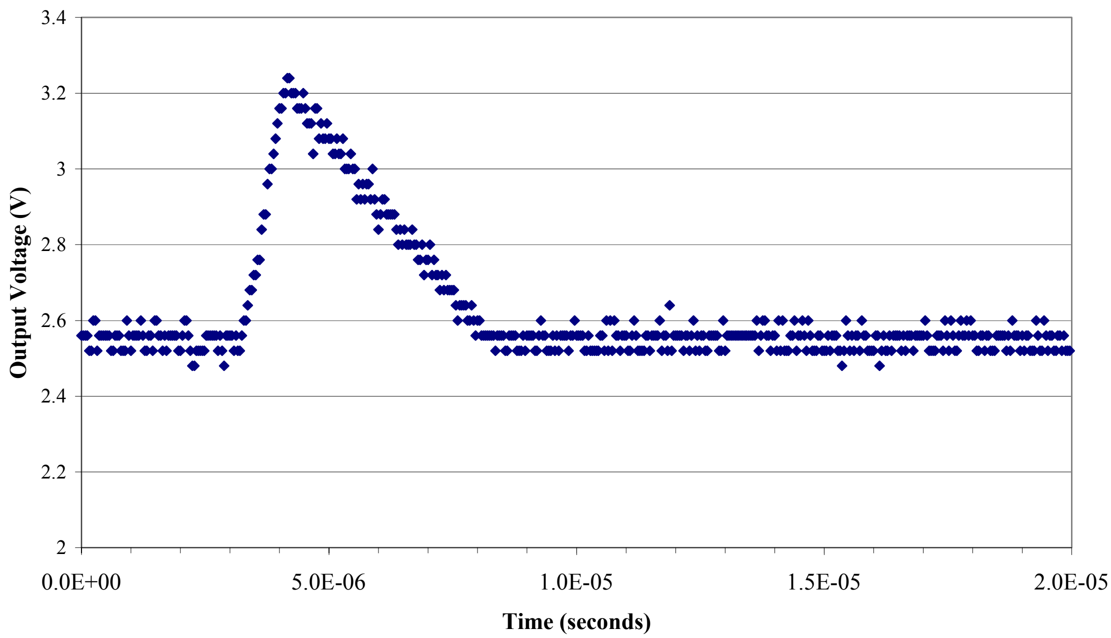

Figure 5: Typical positive going transient.

The rate calculation was performed using CREME96. The total transient rate predicted for this device by the HUP algorithm and allowing for the possibility of proton upset is 3.14×10^{-1} SET per day per device for the GLAST orbit.

Recommendations:
This part may be flown aboard NASA spacecraft provided that sufficient filtering of the output can be provided to prevent the transients from propagating through the circuit or it can be shown that these transients will not affect the circuit and its operation.